Statement of
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before the

Subcommittee on Space and Aeronautics
Committee on Science
House of Representatives

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here to present to you NASA's budget request for FY 2000. It is a great time at NASA. This budget is the first budget for the 21st Century, a century in which humans will live permanently in space, on the International Space Station, and later perhaps beyond. Before we look ahead to the bright future, I want to lay the foundation by looking at the past. Our achievements, and yes, our problems, have prepared us for the future.

While the FY 2000 request represents a decrease from the FY 1999 enacted level, it is the first budget in five years which reflects an increase in the outyears. NASA has undertaken the challenge of the past five years by becoming more efficient. By prioritizing and, as required, cutting programs whose cost estimates were unrealistically low, schedules unacceptably long, or objectives no longer relevant to our mission, we saved valuable resources. With those savings, we started 9 new programs, like Origins, which could help us to answer fundamental questions about life in the universe, and Advanced Space Transportation, which could revolutionize space travel. The percentage of our budget devoted to science and technology has increased from 31% in FY 1991 to 41% today, and is planned to grow to 45% in FY 2004. At the same time, the percentage of our budget devoted to human spaceflight has declined from 48% in FY 1991 to 40% today, and is projected to decline to 35% by FY 2004. As a result, our budget is much more balanced.

We have made difficult choices to enable us to move toward an ambitious, but achievable, future.

We are managing our programs in a fiscally responsible manner. In

1992, a General Accounting Office survey of our major programs identified an average cost growth of 77%. We aggressively attacked the problem, and through management oversight, cost-cutting efficiencies and identifying the problems, have created positive results. Cassini, Mars Global Surveyor, Mars `98 Orbiter, Mars `98 Lander, Stardust, NEAR, ACE, and Mars Pathfinder have all been launched on time and within budget.

We continue to find efficiencies in operations while we improve safety; from FY 1993 to FY 1998, the annual Shuttle budget is down 29%, while the measures of Shuttle safety and performance have improved dramatically. I am proud of the NASA-contractor team that made this happen. Over the same time period, we have improved the manifest lead time by 28%, and increased the maximum lift capacity to the International Space Station by 71%.

Some of my favorite metrics are associated with science spacecraft design and development. In the early 1990s, the average cost of spacecraft development was $590 million. From FY 1995 to FY 1999, it is $205 million, and our goal for FY 2000 to FY 2004 is $79 million. Development time has come down dramatically. In the early 1990s, the average development time for spacecraft was eight years. From FY 1995 to FY 1999, it is five years, and for FY 2000 to FY 2004 our goal is four years. Our annual flight rate went from two in the early 1990s to seven in FY 1995-1999, and we plan on fourteen flights a year on average from FY 2000 to FY 2004. The missions are exciting, as attested to by extensive media coverage and hits on NASA's World Wide Web site, and scientifically sound.

We're not just talking about improvements, we're implementing them. Our Discovery series of spacecraft must be developed in less than three years and for less than $150 million (FY 1992 dollars). Stardust, launched this month to gather and return samples from a comet, took 27 months to develop and cost $120 million. We have 11 planetary spacecraft that, together, cost the same as the single Galileo spacecraft.

We have changed NASA as an institution. In 1995 we conducted a Zero Base Review (ZBR) which created Lead Centers and Centers of Excellence. This led to the elimination of redundant capability at our Centers and allows each Center to focus on what it does best. We redefined the role of Headquarters to define “what” NASA should do, and leave it to the Centers to figure out “how” to make it happen. We met our goal of cutting the total Government/contractor workforce at Headquarters by a factor of three, including cutting the civil servant staff in half. The total NASA workforce has come down from about 25,000 in FY 1993 to 18,545 for FY 1999.

We established a Program Management Council to catch cost overruns and schedule problems, and it is working in programs like Chandra, Clark, and X-33/RLV. Our new approach to contracting, holding contractors accountable for delivering on budget and on schedule, is working in programs like SFOC, CSOC and the TDRS-Hughes contract.

Within NASA, I have established safety as our most important core value. The safety ethic will permeate all NASA activities, on the ground, in the air and in space. Our current program is good; however, we can and will do better. I am working to ensure that all NASA managers understand what is expected of them when it comes to safety and health. Our managers and employees are stepping up to the challenge and working to identify and correct any deficiencies in safety and health as these are identified. No compromises shall be made when lives are at stake.

We at NASA are proud of our Strategic Plan. We have a vision for the Agency and roadmaps to get there. We look forward to working with this committee and others in the coming year as we revise and refine our Strategic Plan. Our FY 2000 Performance Plan, which will be sent to you shortly, will include interim adjustments to our 1998 Strategic Plan. These changes reflect a special emphasis on safety and changes we have made in the NASA organization. Under the Government Performance and Results Act (GPRA), a fully updated Strategic Plan must be submitted by September 30, 2000. We intend to get an early start and will be working with you to enable the Committee's full participation in this process. GPRA, through its requirements for strategic and performance plans, has provided a structure for NASA to prove to the American taxpayer that we do what we say, and that what we do matters.

In order to assure that NASA can implement its Strategic Plan, we have underway a Core Capabilities Assessment, led by the Chief Engineer. The purpose of the assessment is to identify the physical and human assets required to deliver on the established Mission Areas and Center of Excellence assignments identified in the Strategic Plan. We will use the results of the assessment in formulating the FY 2001 budget.

We had a very exciting year in 1998, full of new discoveries and heroes, and a celebration to commemorate our 40th anniversary. The sun rose on the International Space Station with the launch of the first element, Zarya (*Sunrise),* in November, and the world watched as our astronauts connected the U.S. Unity node to it in December. John Glenn returned to space in October for a nine-day research mission. We now have images of the faintest galaxies ever seen. We launched the Mars Climate Orbiter, the third mission to that planet in as many years. The Tropical Rainfall Measuring Mission, a cooperative mission with Japan launched last year, will revolutionize our knowledge of how storms and hurricanes form and dissipate and enable new weather forecasting methods. The U.S.-Canadian Radarsat created the first detailed radar map of Antarctica. We took atmospheric flight to new heights as the remotely piloted Pathfinder aircraft surpassed 80,000 feet. We continued to push the technology to lower space launch costs, making the first selection under the new Future-X program, which is the next step in the space access revolution. This is just a sampling; I will discuss in more detail the achievements of NASA's Enterprises later in the statement.

We see where we have been; where are we going from here?

In five years, the International Space Station (ISS) will be complete and serving as an outpost for humans to develop, use, and explore the space frontier. The ISS will greatly expand research opportunities, leading to exploration breakthroughs, scientific discoveries, technology development and new space products. We will continue to safely fly the Space Shuttle – the workhorse to support assembly for the Space Station. While we do this, we will make fundamental decisions on the long-range strategy for sustaining human access to space through upgrades to the Space Shuttle, or through replacement of the Space Shuttle. We will stay on the road to commercializing space operations, including space transportation, space communications, and the International Space Station. As we transition from operations to core R&D functions, we will lay the groundwork for decisions on extending human presence beyond Earth orbit.

In Space Science, we are poised on the edge of a new undertaking aimed at helping us answer some very old questions: What is our place in the cosmos? How did we get here? Are we alone? You first heard about the Origins program a few years ago. It is time to turn Origins into a reality. In the not-too-distant future, we will move from the planning stages to actual launch and operations of a number of Origins missions. These missions include powerful telescopes to find the earliest structure in the universe, to search for planets around other stars, and to look for potential evidence of life on these newly discovered planets. They also include robotic probes to Mars, Europa, and other targets in the search for the beginnings of life in the backyard of our own solar system. The data gathered from these new missions combined with what we continue to learn about the mysteries of the deep universe and our own Sun from ongoing missions should help us begin to unravel the answers to these questions that are as old as humankind itself. Our goal is simple – to do what no generation before us has been able to – understand our place in the cosmos.

Closer to home, through the Earth Science Enterprise (ESE) we will develop a comprehensive understanding of the total Earth system and the effects of natural and human-induced changes on the global environment. To accomplish this, we are drastically shrinking the size, cost and development time for missions in the next decade. But NASA is not going to stop with just smaller, cheaper versions of today's science satellites or be confined to low-Earth orbit. The state-of-the-art in instrument and spacecraft technologies points to the near future when present-day thousand kilogram, cubic meter satellites are replaced by constellations of micro and nano-satellites with instruments on chips. These advanced satellites will not operate independently of each other—they will be intelligent constellations working together to provide the views having the temporal and spatial resolutions users want. They will be capable of on-board data processing and direct downlink of information to users' desktop computers in near real time at the cost of long distance telephone calls. While accomplishing our science objectives, these advanced satellites will enable the next great advances in weather and climate prediction, improve agricultural productivity, and advance the growth of the U.S. commercial remote sensing industry.

With the Aero-Space Technology Enterprise, NASA seeks nothing less than to revolutionize the way we travel to neighboring cities, countries and planets. The benefits of the communication revolution we are living through today will only be fully realized when it is accompanied by a transportation revolution. In a “wired” economy, we need to move people and goods more safely, more quickly, more efficiently, and with less environmental impact. Today, NASA is concentrating on these public goods issues in partnership with the aviation community. Working with the Federal Aviation Administration (FAA), airlines and industry, we are going to create a commercial aviation system that is safer, more efficient and friendlier to our communities and our globe. And while we are revolutionizing aviation, by significantly reducing the cost and increasing the reliability of space transportation, we will open space to human endeavor. Think of the science missions we do today, and then imagine space transportation systems that support faster missions with three or four times the amount of science at lower cost. Imagine the commercial opportunities that will develop in earth orbit for communications, materials science and pharmaceuticals, space-based power and other applications when the cost is one tenth or even one hundredth of today's costs. That is what we are working for.

We understand the road ahead presents challenges. First among these is keeping our promises on key programs such as International Space Station and the Earth Observing System. This will require in the first case flexibility and determination, and in the second case new information technologies and management approaches. Another challenge is within NASA itself: the design of the NASA organization, the skills of our workforce, the availability of research and technical facilities, the evolution of existing assets, and our interactions with customers, partners, and suppliers must reflect and support the changing nature of our programs. For instance, the emergence of “virtual” structures – collaborative and geographically dispersed teams – to conduct work requires new concepts of organization and management. And our emphasis on commercializing operations while focusing on R&D requires new ways of dealing with customers, partners and suppliers. The third major challenge I see for NASA is that of “continued relevance.” Fundamentally, NASA needs to continue to benefit the taxpayers who foot the bill for a vibrant aeronautics and space program. To meet this challenge, we need to remain focused on our ultimate customer, the taxpayer, while doing a better job communicating the outcomes and benefits of our programs. Mr. Chairman, I believe NASA is poised to meet these challenges and achieve our vision for the future.

FY 2000 Budget

This budget is another important step on NASA's path back to its roots in research and development, an important step towards achieving the vision I just laid out. The FY 2000 budget provides stability in the outyears, and strikes a balance between upholding our commitment to the International Space Station (ISS) and advancing research and technology.

All of you are aware of the challenges facing us and our International Partners on the ISS program. This budget reflects an Administration policy decision to reduce the level of risk to the ISS with a net increase of $1.4 billion over the next five years, including $349 million more for FY 2000 alone. We have enhanced Station budget reserves, are developing a robust Russian Contingency Plan, which includes use of the Shuttle for ISS reboost, development of a U.S. propulsion module, and additional Shuttle launches for logistics support. While advancing the ISS, we have preserved NASA's other core research activities and are investing in new technology initiatives that will provide robust options for exciting NASA missions in the next decade.

As ISS brightens the sky, so will many, many science missions funded in this budget. We are in the middle of launching ten Space Science missions in nine months. With the funds provided by the Administration in this budget, we will be developing Self-Sustaining Robotic Networks. Building on the enormous success of Mars Pathfinder, these self-tasking, self-repairing, evolvable networks of small, highly mobile machines will give us the permanent “virtual presence” outposts we need to achieve high priority Origins science objectives on Mars, Europa, Titan, Callisto and other key points throughout the solar system. Thanks to Administration investments, we will also be developing the other end of the spacecraft technology spectrum in Gossamer Spacecraft. These are lightweight, large-scale, deployable spacecraft that will enable revolutionary, light-gathering capabilities for solar sails, telescopes, and power collection. Through Mars Micro-Missions and a Mars Network, the Administration is also supporting enhancements to the baseline Mars Surveyor program that greatly increase the quality and quantity of the Program's science return and the Program's opportunities in public education and exploration.

We will launch eight Earth Science missions this year, including the first two Earth Observing System missions. NASA will continue to contribute to the “Digital Earth” effort, by fusing Earth Science data, socio-economic data, and other data sets that can be “geo-referenced” and used to communicate a tremendous amount of information to scientists and non-scientists.

A broad new technology initiative I am particularly excited about is the Intelligent Synthesis Environment (ISE) that will revolutionize the way NASA conceives, plans, and develops its missions. In today's engineering environment, we and industry take too long to develop our missions and effectively commit about 90% of cost very early in the development cycle when we only have about 10% of total design knowledge. Over the next five years NASA will research, develop, and implement the tools and processes to dramatically reduce spacecraft development time while creating much higher confidence in performance and total life cycle cost estimates. ISE will exploit emerging advances in ultra-high speed computing, advanced communication networks and totally new analysis methods; it will allow us to “virtually” build and test vehicles and systems before we spend money on expensive hardware. When fully deployed, ISE will enable geographically dispersed scientists and engineers to function as an integrated, collaborative team with the understanding and knowledge necessary to develop complex missions faster, with better- understood risk and much lower life-cycle costs.

We are continuing to focus on high-priority aeronautics research, aggressively pursuing our goals in aviation safety and systems capacity as well as next-generation design tools. And our pursuit of cheaper, more reliable space transportation for the next century continues with our Reusable Launch Vehicle technology program and the ongoing, industry-led Space Transportation Architecture Study. This Study was initiated last year to help us develop an investment strategy for reducing the cost of access to space by using commercial capabilities. The study is assessing: 1) if the Space Shuttle should be replaced; 2) if so, when the replacement should take place and how the transition should be implemented; and 3) if not, what upgrades should be made to continue safe and affordable flight of the Space Shuttle. We awarded study contracts to the Boeing Corporation, Kelly Space and Technology, Lockheed Martin Corporation, Orbital Sciences Corporation, and Space Access – representing the entire spectrum of players in the launch vehicle business – to solicit their assessments of future options to commercialize NASA's space launch requirements. The industry teams gave NASA their final reports three weeks ago. These results are being independently assessed and will be integrated by an in-house team into space transportation architecture options. Over the next few months, additional work will be tasked to refine and further develop some of these options. From these options, the NASA Space Transportation Council will make recommendations this summer to myself and the Administration concerning a future space transportation investment strategy. I will then make recommendations to the Administration this fall as part of the FY 2001 budget process.

As we approach the new millennium, I would like to describe NASA's work on the Year 2000 (Y2K) problem. We have taken aggressive actions to ensure that our missions, systems, and supporting infrastructure and facilities are not disrupted by the transition to the year 2000. As of January 31, 1999, 87 percent of our 158 mission critical systems are Y2K compliant. NASA has completed renovation on all but one system (Y2K work on the SOHO ground system has been deferred until full recovery of the spacecraft on orbit is complete). Validation was completed on all but two mission critical systems in January. As of today, both of these systems have completed validation. Our plans meet or are ahead of Government-wide guidelines for implementation. Ninety-eight percent of NASA mission critical systems will be implemented by February; all will be implemented and certified as compliant by March 1999.

Our priority remains focused on the Y2K readiness of NASA missions and programs. We are working aggressively with our international partners to resolve any potential Y2K impacts. During April to July 1999, NASA programs and projects will ensure Y2K operational readiness that is validated and certified through end-to-end testing or high fidelity simulation. This includes the International Space Station, the Space Shuttle program, Space and Earth Science programs, and NASA's mission operations and communications services. As a further assurance, each NASA Enterprise and field Center is preparing business continuity/contingency plans to provide an acceptable level of NASA functions in the event of failures of internal or external assets or services due to Y2K anomalies. NASA is committed to ensure that the Agency transitions safely to the new millennium with zero failures or significant malfunctions and that any unforeseen discrepancies are resolved with minimal impact on normal operations.

We are excited about what the future holds for NASA. The FY 2000 budget of $13.6 billion provides not only continuity and stability, but also a moderate investment in far-term technologies and planning. This vote of confidence from the President that we are ready and energized to tackle new challenges in the new millennium is a challenge we proudly accept.

NASA's Enterprises

Human Exploration and Development of Space Enterprise

International Space Station

The International Space Station (ISS) has become a reality. The foundation, befittingly named Zarya, for it marks the dawn of a new era, was lifted to orbit aboard a Russian Proton launch vehicle last November. A month later, Unity was carried to orbit aboard Shuttle Endeavour and berthed with the Zarya module. Before long, passageways from Unity will link to other chambers such as: Destiny, the U.S. laboratory; the Russian Service Module; and the airlock.

Astronauts James Newman and Jerry Ross made it look easy, connecting umbilicals providing power and communication links from Zarya to Unity, bringing Unity's on-board systems to life. This is the first time ever that two such complex international spacecraft--built 10,000 miles apart, and assembled permanently in orbit over a period of a few short days—has been accomplished. We understood that the complex, international nature of this venture would present unprecedented challenges, because we would not be able to perform integrated testing of all international elements on the ground. The Zarya/Unity mating was truly an outstanding effort by the NASA/RSA team. Many challenges were overcome to reach that moment, and we know that many formidable tasks lay ahead. Since the beginning of the International Space Station Program, we have worked through many questions and uncertainties with our partners to achieve definite, measurable, and notable forward progress. In 1994, we were moving out of the design phase and into manufacturing. By 1997, we began to see major subsystems and elements take shape as we entered into test and validation activities. We began to integrate these systems with the Shuttle fleet. Today, while the Boeing developmental effort is over 80% complete, we continue to have elements in all phases of development, and operational elements on orbit. The International Team has demonstrated that it is fully committed to working together to overcome new challenges as they arise, to assure safe design and operations and to make the ISS a reality.

Russia

When provided with adequate resources, the Russian Space Agency (RSA) has demonstrated worthy performance. However, despite a high level of commitment by RSA, Russia's fiscal realities continue to impede RSA's ability to deliver its substantial contributions to the ISS in a timely manner. Those contributions include propulsive attitude control, reboost, early crew quarters and life support, crew rescue, and command and control during the early assembly period. NASA has plans for U.S. capabilities in all these areas, which provide backup and in the long-term make ISS operationally more robust. But the costs of delaying the assembly until these U.S. capabilities are available would be significant; the prudent course is to continue to seek Russia's contributions.

NASA's approach to contingency planning has been to incrementally fund activities that permit station development to continue to move forward, although not as originally planned, should the planned contributions of our ISS partners not be delivered as scheduled. Our Contingency Plan to mitigate the financial and schedule risk from potential shortfalls in Russian contributions consists of: (1) building up U.S. capabilities as backup to protect against possible Russian shortfalls, which will also make the ISS more robust; and, (2) potential purchases from RSA in specific areas where Russian goods and services are of value to the United States.

In October 1998, to provide funding stability to RSA, NASA purchased for $60 million valuable crew research time and stowage space in Russian elements of the ISS. To mitigate further schedule disruptions and cost growth, NASA is considering plans to continue contracting with RSA for additional goods and services of value to the U.S. We are carefully monitoring three areas before we make decisions regarding any follow-on contract with RSA for goods and services: 1) confidence in the Service Module launch schedule, based on successful testing, shipment to Baikonur, and funding flow; 2) clarity on the Russian Government plans for the future of the Mir, specifically including validation that any extension of Mir operations will cause no interference with Russian Government funding for their commitments; 3) clear understanding from RSA that other Russian hardware and vehicles they have committed for ISS are being produced. NASA has budgeted $100 million in FY 1999 to procure goods and services, which could include a Soyuz vehicle needed by the United States to enable a 6-person ISS crew prior to the deployment of a U.S. crew return capability. However, this budget includes no provision for purchases from Russia in FY 2000 and beyond. We will continue to monitor the overall Russian situation in this regard.

The Interim Control Module (ICM), another element of NASA's contingency plan, can provide propulsion and attitude control capability. Through innovative Shuttle flight planning, NASA has developed an “each flight” reboost capability, under which NASA could, if necessary, offset as much as a 30 percent shortfall in Russian Progress vehicle propellant logistics. We are modifying the Orbiter fleet to enhance this Shuttle reboost capability. When coupled with the ICM's capabilities, Shuttle reboosts will provide needed contingency protection to safely maintain elements already in orbit, and allow us to continue ISS assembly in the event of Russian shortfalls until a U.S. permanent propulsion module can be deployed. As a result of our review of the Propulsion Module requirements and implementation plan on February 17, we have authorized the contractor to proceed with procurement of the next set of long-lead parts, and to prepare for a Systems Requirements Review by April 1999. Delivery of the Propulsion Module could be as early as FY 2002.

Relative to the Service Module, Mr. Koptev, RSA's Director, informed me last month that despite running Service Module (SM) integration tests around the clock and on weekends, some schedule slippage has occurred due to normal technical difficulties. Our ISS management team is currently in Russia for a Joint Program Review where RSA will provide insight into the progress of the SM, allowing the partners to evaluate a revised launch date for the Service Module. During our assessment last April, we knew that the July 1999 schedule for SM launch was aggressive and that a September date was possible. This slippage does not impact the elements already in orbit.

Mir Space Station

Over the last six months, Russian news media have been reporting on the possibility of extending the life of the Mir space station. RSA has repeatedly made clear that the Russian Government's top priority for human space flight is the ISS. Any potential extension of the Mir program would require private funding and must not in any way impact Russia's ability to meet its commitment to the ISS program. In mid-January, Russian Prime Minister Primakov signed a decree outlining the conditions under which Mir could be extended on orbit on a commercial basis. RSA indicated that a final decision on a potential extension of Mir would be made in the Spring timeframe, depending on the success of finding a commercial investor. Assuming no investors come forward, RSA has stated that it intends to deorbit Mir in late summer. RSA has publicly stated that, currently, there are no investors coming forward. NASA is working closely with RSA to understand the status of their Mir deorbit plans, and related implications to their ISS commitments.

ISS Budget

Last year, the Committee heard from an outside task force of independent experts on the projected U.S. cost for the ISS. The Task Force report specifically highlighted the extraordinary level of complexity inherent in the ISS and concluded that the Program had made "notable and reasonable progress over the past four years" and faced no extraordinary or programmatic "show-stoppers." Nonetheless, the report concluded that Program cost and schedule projections were optimistic given the challenges ahead, partially due to domestic cost increases and partially due to the uncertain status of the Russian contributions.

We recognize the validity of findings of this Task Force, particularly in the resources needed for increased risk mitigation, schedule protection, and crew return capability. In my October 7, 1998, testimony before the Committee on Science, I stated that the Agency would require additional resources to continue forward with this valuable laboratory in space. I am happy to report that the President's FY2000 budget request provides an additional $349 million in FY 2000, and a total net augmentation of $1.4 billion over five years, reconfirming the Administration's strong support of the ISS. We also recognize the recommendations of the Task Force in a number of management areas, and recognize our fiscal responsibility to the American taxpayer to balance all aspects of this program and manage within the resources available. The Administration has highlighted this responsibility by establishing the management of risks in development of the ISS as one of the Administration's Priority Management Objectives in the President's FY 2000 Budget. We have already begun to make management improvements, including the initiation of a new management review process for those activities not under the prime contract, and are committed to making continued improvements. We are also making schedule adjustments and rephasing some content to limit the financial augmentation required.

Development Status

In 1999, development activities are phasing down, while operations and research utilization activities are escalating. The FY 1999 vehicle development budget is nearly $600 million below FY 1998, and the number of contractors supporting the program is several thousand less than at the peak of the development effort. This trend will continue this year, with several thousand additional contractors transitioning to other tasks, such as sustaining engineering or other non-ISS work. ISS operations planning is now well underway. In fact, NASA is already working plans for operations that will occur in FY 2001. Mission Control Center-Houston is already operational, and has overall authority and responsibility for the safety and operations of the ISS and crew. Mission Control Center-Moscow is currently performing the actual uplink of commands, and will continue to do so until U.S. communications and control systems become fully operational with the U.S. Laboratory delivery to orbit in FY 2000.

Near-term, high visibility activities this year include the flight of critical ISS spares and an external Russian cargo crane to be flown in May 1999. This flight will be followed by the launch of the Russian Service Module, providing the early crew quarters and ISS propulsion systems. Next, another Shuttle logistics flight is scheduled, followed by Shuttle flights to assemble some of the U.S. external framework, electronics, communications, attitude control and thermal systems prior to flight of the first crew in early 2000.

Near-term hardware development activities are focused on completion and delivery of the U.S. airlock. The ISS involves many systems which entail multiple, identical elements, such as the photovoltaic arrays, of which four are planned. For the most part, the high-risk, first elements of these systems have been delivered to KSC. This year will begin the delivery to KSC of many of the subsequent, identical items. We will continue Multi-Element Integration Testing (MEIT) effort on the next complement of U.S. elements: the initial truss segment, the early thermal control system, the first Photovoltaic Arrays, the Canadian-built ISS robotic arm and the U.S. Laboratory, Destiny.

In 2000, we will launch the first ISS crew to orbit, as the launch of the first Soyuz to ISS enables permanent crew capability for three people. Microgravity research capability will be available in the spring of 2000, with the outfitting of the U.S. laboratory, Destiny. When Phase II of ISS is complete in late FY 2000, the Station configuration will include Unity, Destiny, pressurized mating adapters, power, airlock, and Multi-Purpose Logistics Module (MPLM); Zarya, the Russian Service Module and Soyuz; and the Space Station remote manipulator system (SSRMS) provided by Canada. By early 2003, the ISS configuration will also include the second U.S. node, truss segments, three solar arrays, the Japanese Experiment Module (JEM) and resupply/support vehicles. In 2004, U.S. Station development efforts will near completion, with the delivery of a six-crew capability on orbit.

International Partners

The work of NASA's other international partners on the ISS program is proceeding well and according to plan. All of the partners have stated their commitment to do whatever possible to help Russia fulfill its obligations to the ISS program and to ensure that the program remains on track.

NASA is also working aggressively with all of its partners to ensure that all ISS components are fully Y2K compliant. When I attended the historic launch of Zarya from Baikonur on November 20, 1998, I had the opportunity to meet with the head of each partner agency on the Year 2000 issue. Each agency gave an in-depth presentation on their work to ensure full Y2K compliance, and reiterated the commitment to achieve compliance early this year.

The various international components of the ISS are progressing nicely. The Canadian Space Station Remote Manipulator System, or “Robotic Arm,” will be shipped to Kennedy Space Center in April, after stringent testing. The European Laboratory development is on schedule and NASA is continuing discussions with the European Space Agency (ESA) about the possibility of ESA providing critical crew rescue vehicle components. The second Multi-Purpose Logistics Module (MPLM), built by Italy, is scheduled for delivery to Kennedy Space Center in August. The Japanese Experiment Module and Centrifuge Accommodations Module (CAM) development is on schedule. Finally, the Brazilian Space Agency has selected its prime contractor and is proceeding with its hardware contributions.

Research Utilization

We are continuing to make progress on ISS research planning and facilities development. However, because of schedule delays and the need to bolster development reserves, we have slowed the development of research equipment. Assuming that the Service Module is launched by September 1999, we estimate that the Russian-driven delay to the assembly sequence already has slipped utilization flights on average 6-8 months. The research funding for ISS is still growing and will, in fact, double by FY 2001 over FY 1998 levels, but the rate of growth is slower than previously planned. As a result, some funding for research facility development has been rephased from FY 2000-2003 into FY 2004 and beyond.

We are focused on developing most of the permanent research facilities, while leaving adequate margin in the research utilization budgets for some investigation-specific hardware. Our approach is to: protect research facility hardware deployment and schedules; maintain multi-use hardware schedules (EXPRESS Racks and Pallets, Window Observation Research Facility); maintain planned flight investigation buildup rate to the maximum extent possible, fund research utilization (experiment unique hardware and support), sub-rack integration at approximately 70 percent of that previously planned; and fund payload operations and integration (analytical integration, operations facilities, training) at approximately 85 percent of that previously planned. The ISS program will continue to emphasize the early research program by utilizing recently added Shuttle logistics flights, accelerating the Human Research Facility, and adding two EXPRESS racks to assembly flights 5A.1 and 6A in FY 2000.

ISS Commercialization

We were pleased with the passage of the Commercial Space Act of 1998 (P.L. 105-303).

This visionary step will serve the American people well by demonstrating our government's commitment to the economic development of space. NASA is dedicated to continuing its leadership in this important area. In conjunction with the Act, we released our draft Commercial Development Plan for the International Space Station last November. The ISS represents a platform in space of unprecedented capability. We envision that it will become a seed for emerging commercial activity in the coming decade and we are moving ahead to ensure this outcome.

Our goal is to serve as a marketplace foundation and stimulate a national economy for space products and service in low-Earth orbit, where both demand and supply area dominated by the private sector. In partnership with the private sector, we plan to initiate a series of pathfinder activities that could lead to businesses with profitable operations over the long run and that become self-sustaining without public funding. One area we are examining closely is the provision of ISS resupply and servicing by multiple commercial competitors. Our draft Commercial Development Plan provides a summary of both our overall strategy and potential tactics we intend to pursue in the coming years. It will also benefit from a private sector review, now underway, and the independent market studies and cost analyses which we have recently initiated. We look forward to reporting our progress as we open the path for 21st century economic expansion in space.

X-38 and CRV

The Crew Return Vehicle (CRV) will provide a seven-person crew return capability for the ISS, beginning no earlier than 2004. The Space Transportation Architecture Studies (STAS) are assessing the role of systems that provide not only return, but also delivery of humans to orbit in a range of potential future architectures. Based on the STAS architecture concepts, NASA is evaluating the potential of a CRV to evolve to serving a dual-purpose role, or evolve to a Crew Transfer Vehicle (CTV) that can deliver and return humans. NASA will finalize the CRV requirements and issue a draft Request for Proposals (FP) for comment before finalizing the plan for the CRV. The results of the STAS and the potential role of a CRV/CTV in potential future architectures will be integrated into the final CRV plan.

Space Shuttle

The Space Shuttle Program completed four flights in FY 1998. FY 1999 began successfully with STS-95 in October, the mission on which Senator John Glenn returned to flight. Most recently, STS-88 opened a new era for the Space Shuttle – support of the assembly operations for the International Space Station. No longer just a research platform, the Shuttle is now fulfilling its original objectives, as the workhorse that will carry equipment, supplies and the personnel required to assemble the International Space Station during the next several years.

During 1998, the Super Lightweight Tank was successfully flight demonstrated, increasing payload capacity to ISS by over 7000 lbs. The SSME Block IIA improvements, which improved the reliability on ascent, clearly demonstrate that NASA's investment in safety and supportability initiatives have dramatically improved the performance and reliability of the fleet.

In 1998, the Space Shuttle Programs principal operational contract, the Space Flight Operations Contract (SFOC), now in its third year, made great strides. All of the Phase I contracts have been successfully incorporated and the first of the Phase II production contracts, the Solid Rocket Booster project, transitioned to SFOC in July 1998. The External Tank project is scheduled to move under SFOC in FY 2000. The smooth transition of other projects to the SFOC is expected to occur as major development activities are completed.

This year, the Shuttle will support ISS logistics and assembly flights and a number of research objectives. In addition to setting the stage to begin ISS utilization, the Shuttle Program is prepared to launch the Advanced X-ray Facility (AXAF), now called Chandra, and a payload for the National Imagery and Mapping Agency (NIMA).

When the Orbiter Atlantis returns to flight later this year, after its recently completed Orbiter Maintenance Down Period and installation of major modifications, it will take advantage of numerous other upgrades. Examples are:

- The Multifunction Electronic Display System (MEDS), a Phase I upgrade, is a state-of-the-art integrated display system used in the cockpit of the orbiter.

- The Micro-meteoroid and orbital debris (MMOD) protection system for the Orbiter radiators and wings, a Phase II upgrade, protects the vehicle from the potential damage to critical systems while in orbit.

- Solid Rocket Booster aft skirt improvements reduce risk during initial seconds after main engine ignition.

NASA continues to place the highest priority on the safe launch, operation and return of the Space Shuttle and crew. While we continue to seek efficiencies in the Space Shuttle Program, the FY 2000 budget of $2,986.2 million will enable the system to successfully meet its goals: 1) fly safely; 2) meet the flight manifest serving diverse customers; 3) improve supportability; and 4) improve the system. The Space Shuttle Program's FY 2000 budget remains constant, with a slight decrease of $12 million from FY 1999. We continue to seek efficiencies in the Space Shuttle Program. The Space Shuttle manifest currently reflects eight missions scheduled to fly during FY 2000 – seven ISS assembly flights and the third Hubble Space Telescope servicing mission.

Space Shuttle Operations ($2,547.4 million) includes sustaining engineering, hardware production, ground processing, launch and landing, mission operations, flight crew operations, training, and logistics.

Funding for Safety and Performance Upgrades ($438.8 million) provides for modifications and improvements to the flight elements and ground facilities including expansion of safety and operating margins. This budget also includes supportability upgrades, which will be used to develop systems to combat obsolescence of vehicle and ground systems in order to maintain the program's viability into the next century.

This budget will enable the enhancement of the Space Shuttle vehicle capabilities as well as the replacement of obsolete systems and components. We will address vendor loss, aging components, high repair cost of Shuttle-specific devices, and negative environmental impacts of some out-dated technologies.

Since 1992, Shuttle program costs have decreased by about 37% (factoring in inflation), while significantly improving flight safety. As we continue to look for efficiencies, we will also look for opportunities to improve the system, including reducing the standard manifest time period and simplifying the payload review process to allow flexibility for the science community. The Space Shuttle continues to prove itself as the most versatile, robust, and reliable space vehicle in use today.

Consolidated Space Operations Contract (CSOC)

On September 25, 1998, NASA awarded the Consolidated Space Operations Contract (CSOC) to a team led by Lockheed Martin. This contract (base period of five years, and an option period of five years) began on January 1, 1999, when five current space operations contracts transitioned to CSOC. During the remainder of the CSOC program, 10 other existing space operations contracts will transition to CSOC. The CSOC contract provides a new approach to space flight operations, consolidating and privatizing operations facilities under a single contract. Over the potential 10-year life of the contract, CSOC is expected to provide cost savings to the taxpayer of $1.4B in the conduct of Space Communications and Mission Operations for NASA Missions.

The major features of the CSOC Integrated Operations Architecture (IOA) that define the implementation are:

- Consolidation of mission and data services;

- Application of architectural changes, based on commercially developed technology;
- Centralization & automation; and
- Conversion to commercial providers

NASA has applied a 25% small business goal to the CSOC contract. Lockheed Martin and its teammates, AlliedSignal and CSC, propose to meet this target and are in the process of implementing the necessary actions to meet the goal.

Inherent in the successful implementation of CSOC are reductions in the contractor work force supporting space operations at five NASA Centers over the 10-year period of performance. There will be initial reductions to the work force at the beginning of the CSOC program, and these reductions are currently being implemented. Following this transition, work force impact is, on average, slightly less than 100 jobs per year in total at all five NASA centers. The CSOC contractor team expects to absorb these out-year-staffing reductions based on natural attrition and reassignment of employees to other non-CSOC programs.

Life and Microgravity Sciences and Applications

NASA's Office of Life and Microgravity Sciences and Applications (OLMSA) is eagerly looking forward to the remarkable new opportunities that will be available on the ISS. Our ISS Phase I Program and scientific experiments on Spacelab gave us tremendous insight into the possibilities as well as the challenges we will encounter as the ISS becomes fully operational.

Our past successes provide the foundation upon which future research will be based. In FY 1998, NASA supported a total of 850 ongoing, peer-reviewed investigations. Preliminary analysis suggests that the commercial cost share investment with NASA in space products and service development for FY 1998 was approximately $45M. Twenty-one new industry partners joined OLMSA's Commercial Space Centers. The organizational merger of our basic science and commercial research elements is beginning to show synergies and efficiencies as the two groups work together to solve common problems and to use common hardware.

We look forward to increased commercial applications of NASA research. Understanding the structure of a virus is key to understanding its behavior. Dr. Alex MacPherson published a structure of the satellite tobacco mosaic virus at far greater resolution (1.8 Angstrom) than has ever been published before. Mosaic virus crystals grown in space increased by a factor of four over crystals grown on the ground. Basic discoveries in this field may hold great potential for supporting near-term commercial applications. For example, Biocryst Pharmaceuticals, Inc. and Johnson & Johnson have agreed to collaborate on the development of a drug (neuraminidase) to treat influenza. BioCryst used data from protein crystals grown on Earth and in space to develop four lead product candidates that have performed strongly in pre-clinical trials against both influenza A and B.

We had two exciting science flights last year. The Neurolab Mission in April 1998, a NASA contribution to the “Decade of the Brain,” helped to expand understanding of how the nervous system develops, functions in, and adapts to a microgravity environment. We performed 26 peer-reviewed investigations and collected a wide range of physiological and behavior data in-flight and post-flight. STS-95, in October 1998, flew a SpaceHab module dedicated to multidisciplinary research. This mission marked the first space flight collaboration between NASA and the National Institute on Aging. It carried 26 commercial research experiments sponsored through NASA's Commercial Space Centers. Senator John Glenn's involvement highlighted health care and healthy aging. The wealth of scientific data accumulated during this flight will help validate apparent symptomatic similarities between the effects of space flight and aging.

In FY 1999, preparation for use of the ISS will continue. In order to maximize return on the ISS investment, we will continue to build up and maintain a community of over 900 experienced principal investigators. We are committed to continue this buildup in FY 2000. The Commercial Space Centers plan to add 9 new industry affiliates and 10 new university affiliates in 1999. To enhance science and technology development activities in an era of constrained budgets, NASA continues to leverage resources through partnerships and cooperative ventures.

The FY 2000 budget request for OLMSA, $256.2 million, will support a variety of activities on ISS, the Space Shuttle, and on the ground. Early in the assembly phase of the ISS, research will concentrate on small-scale investigations, an approach that has been successfully demonstrated on both the Space Shuttle and on the Russian Mir space station. We will study the environment, habitability, and safety. To help maintain NASA's research communities during the ISS build-up, NASA plans to add a SpaceHab research mission (STS-107) in early FY 2001. Increased Shuttle middeck locker opportunities using both the utilization and assembly flights have been part of ISS planning. In addition, we are developing a plan for a stand-by research mission which can be inserted into the Shuttle Manifest should the opportunity arise.

Research opportunities aboard the ISS will start in earnest with the arrival of the crew and the Human Research Facility (HRF) in early 2000. The HRF will help us understand the basic mechanisms of adaptation to microgravity and help develop and validate countermeasures to maintain crew health on orbit. NASA will continue to augment its efforts in validating countermeasures with research carried out by the National Space Biomedical Research Institute (NSBRI), and ground-based research and technology programs. One of the major concerns is the biological impact to the crews of the effects of radiation. NASA, through peer-reviewed research and in cooperation with organizations such as Loma Linda University, Brookhaven National Laboratories, and NIH, is developing countermeasures to increase predictability of biological damage and lower risk to crew health.

We will continue to pursue innovative sensor technologies. We plan to create an Environmental Systems Commercial Space Center to foster commercial interest and participation in research and technology development for recycling air and water and monitoring the spacecraft cabin environment.

Gravitational Biology and Ecology flight experiments in FY 2000 will provide information on the effects of microgravity on plant growth and development, and the effects of gravity on plant photosynthesis and respiration. Research will begin in evolutionary biology with participation of at least five research institutions. Flight research on the effects of microgravity on avian development will be carried out and research proposals on biologically inspired technologies will be implemented. Microgravity Research flight experiments in FY 2000 in the area of colloid physics will help refine the technologies required for photonic devices used in optical communications and computing.

Space Science Enterprise

NASA's Space Science program is scientifically robust and more ambitious than ever. It is also more streamlined, effective, and cost-efficient to the U. S. taxpayer. Beginning with the launch of the Deep Space 1 mission on October 24, 1998, the Space Science Enterprise entered a nine-month period in which it will have ten launches. Six missions have already been launched successfully: DS-1; two Mars '98 Surveyors and the piggyback DS-2 microprobes; four payloads on STS-95; the Submillimeter Wave

Astronomy Satellite; and Stardust, a comet sample-return mission.

Later this month we will launch the Widefield Infrared Explorer (WIRE) from Vandenberg Air Force Base. In April, we will launch the Tomographic Experiment using Radiative Recombinative Ionospheric Extreme Ultra-Violet and Radio Sources (TERRIERS) spacecraft. In late May or early June, we will launch the Far Ultraviolet Spectroscopic Explorer (FUSE) aboard a Delta rocket. To round out this busy launch period, we hope to launch AXAF, recently renamed the Chandra X-ray Observatory, aboard STS-93 in the July timeframe. In recent months, technical problems with circuit boards identical to those in Chandra were discovered in a non-NASA satellite. Testing continues to proceed with these circuit boards on the Chandra observatory. I want to assure you that we will not launch Chandra until we have thoroughly tested all boards and ensured the proper operation of the door, and are comfortable that every precaution has been taken to ensure mission success.

But this intense launch schedule is only part of the story, because the existing Space Science programs and missions continue to deliver a wealth of new scientific data and insight.

Results from the Mars Global Surveyor (MGS) and Mars Pathfinder spacecraft show mineralogical and topographic evidence confirming earlier indications that Mars had abundant water and thermal activity in its early history. Measurements from the spectrometer aboard MGS show a remarkable accumulation of the mineral hematite, well-crystallized grains of ferric oxide that typically originate from thermal activity and standing bodies of water. Measurements by the Mars Orbiter Laser Altimeter (MOLA) aboard MGS are providing striking new views of Mars' north pole and the processes that have shaped it. MOLA data reveal that the 750-mile-diameter polar ice cap has a maximum thickness of 1.8 miles. The cap is cut by canyons and troughs that scientists believe were carved by wind and evaporation of ice.

Closer to home, the Discovery program's Lunar Prospector spacecraft has provided further indications of water ice at the Moon's poles, which remains under scientific debate. The spacecraft has recently entered a lower lunar orbit for even more precise mapping activities. Although its orbital capture has been delayed by about a year, the Near Earth Asteroid Rendezvous mission performed a swingby of its target asteroid, Eros, adding to our still small inventory of in-situ data on small bodies.

Further out in the Solar System, the Galileo spacecraft continues to provide insights into the mysteries of Jupiter and its moons. Last year, I reported that Galileo found very strong evidence of a subsurface liquid ocean on the Jovian moon Europa. Recent data from Galileo suggest that Callisto, another moon of Jupiter, may also have a liquid ocean under its icy, cratered crust. The common evidence for past or present liquid water on Mars, Europa, and Callisto provides a key initial step in our Origins program. Galileo images have also shown how Jupiter's intricate, swirling ring system is formed by dust kicked up as interplanetary meteoroids smash into the giant planet's four small inner moons.

The Hubble Space Telescope continued its impressive performance. This year, Hubble observations made a watershed event in astronomy—the first potential direct image of a planet outside our solar system—another key initial step for Origins. A “long exposure” infrared image taken with the NICMOS camera has allowed astronomers to peer into a previously unseen realm of the universe and uncover the faintest galaxies ever seen. During the STS-95 mission last fall, a suite of new instruments and technologies were tested and validated to ensure the success of Hubble's third servicing mission in 2000.

Last year we confirmed the existence of a special class of neutron stars, now dubbed “magnetars.” Magnetars are dense balls of super-heavy matter, no larger than a city, but weighing more than the Sun. They have the greatest magnetic field known in the Universe, so intense that it powers a steady glow of X-rays from the star's surface, often punctuated by brief, intense gamma-ray flashes, and occasionally by cataclysmic flares like the one observed on August 27, 1998. Our own star provided surprises as the Solar and Heliospheric Observatory (SOHO) team dramatically recovered from what was thought to be a lost mission, and obtained the first evidence of long-theorized quakes on the surface of the Sun. Another important first for NASA Space Science is the ongoing demonstration of ion main propulsion and other new technologies on the Deep Space 1 technology validation spacecraft.

We have learned some fascinating new things about our own star, the Sun, as well. Last May, the first images from NASA's Transition Region and Coronal Explorer spacecraft revealed activity in the solar atmosphere in stunning detail and included the first detailed observations of a magnetic energy release, called a magnetic reconnection. Less than a month later, SOHO, a NASA/European Space Agency mission, revealed a rare celestial spectacle: two comets plunging into the Sun's atmosphere in close succession. In July, scientists confirmed for the first time that solar flares produce seismic waves in the Sun's interior that resemble those created by earthquakes. (Enough energy was released from that quake to power the United States for 20 years at its current level of consumption.)

This year has certainly been impressive, but we are very excited about what is ahead as well. The proposed budget of $2.197 billion, an increase of $77 million over last year's budget, continues to support a strong and well balanced Space Science program that will allow us to carry on research of the Sun, the Solar System, and the Universe. It maintains support for the Origins Initiative to search for planets around other stars, to study galaxies and stars as they are born, and to look for evidence of life elsewhere in the solar system and the universe. The FY 2000 budget also maintains support for a multitude of ongoing missions.

The budget request features five new items in the Space Science Enterprise. Two new program elements are funded in the Mars Surveyor program beginning in FY 2000: Mars Network and Micromissions. Mars Network will develop communications capability to provide a substantial increase in bandwidth and connectivity from Mars to Earth, thus greatly improving the scientific and educational return for this ongoing program. Mars Micromissions will provide low-cost capability for delivering small payloads, including telecommunications elements of the Mars network. Competitively selected Micromissions will deliver up to a 50-kg science payload to Mars to collect high-priority scientific data. The first planned Mars Micromission is the “Mars Airplane,” which will commemorate the 100^{th} anniversary the Wright brothers' historic first flight in 2003.

Also in the FY 2000 request, the Cross-Enterprise Technology program budget is augmented to include funding for three initiatives: Self-Sustaining Robotic Networks; Gossamer Spacecraft; and Next Decade Planning. Self-Sustaining Robotic Networks will build on the success of Mars Pathfinder. This initiative's goal is to extend ongoing advances in spacecraft automation and miniaturization technologies to produce self-tasking, self-repairing mobile robots for permanent, “virtual presence” planetary science and exploration outposts in challenging environments. The Gossamer Spacecraft initiative provides additional funding to develop and demonstrate the deployment, control, and utility of ultra-lightweight deployable structures. These structures can be used as sun shields, ultra-large telescopes, solar arrays, antennas, or solar sails, and will revolutionize a wide variety of missions, including those of other agencies such as NOAA and the Air Force. Next Decade Planning will support the improved, Agency-wide planning to develop and refine concepts and technologies for a robust menu of potential future civil space programs.

As we continue to explore our Universe, we bring scientific benefit not only to the space science community, but to America's taxpayers and citizens of the world. Our Space Science program is exciting and relevant, as attested to by numerous front-page stories and magazine covers, and by World Wide Web interest in this field in the past few years. NASA has made countless scientific discoveries and advances over its 40-year history, but stay tuned – there is much more to come.

Earth Science Enterprise

Since its creation in 1958, NASA has been studying the Earth and its changing environment by observing the atmosphere, oceans, and land, and their influence on climate and weather. The perspective afforded since the beginning of the space age planted a growing seed of knowledge—we now understand that the key to gaining a better understanding of the global environment is exploring how the Earth's systems of air, land, water, and life interact with each other. This approach, called Earth System Science, integrates fields like meteorology, oceanography, biology, geology, and atmospheric sciences.

The Earth Science Enterprise continued to make great progress through 1998. We have recently revealed evidence to suggest that the 1997-98 El NiÒo event may have been a major contributor to the average global sea level rising about eight-tenths of an inch before it returned to normal levels, according to scientists studying TOPEX/ Poseidon satellite measurements of sea surface height. While NASA can accurately measure global sea level rise today, we really need a decade or more of sustained research before we can say with certainty whether there is a definitive link between sea level variation and climate change. The SeaWiFS instrument on Orbview-2, a commercial satellite launched in 1997, is providing data on ocean biological productivity for NASA research, and the firm is marketing these same data to the commercial fishing, oil, and shipping industries. The data are being procured by NASA as a "data buy" from the commercial supplier.

NASA has also begun to measure rainfall in the tropics and sub-tropics. Approximately two-thirds of the global rainfall occurs within the tropics, directly influencing our day-to-day weather, according to scientists studying measurements of sea surface height from the US/French TOPEX/Poseidon mission. The Tropical Rainfall Measuring Mission (TRMM), a joint endeavor with Japan which was launched in 1997, is for the first time delivering accurate measurements of precipitation over the global tropical oceans, a critical indicator of climate patterns over the whole world.

Polar regions also have a major influence on moderating the Earth's climate. Until the fall of 1997, Antarctica, a region the size of Canada and Alaska combined, had never been fully mapped at high spatial resolutions. The Antarctic Mapping Mission (AMM) is accomplishing this mapping using data from the Canadian Radarsat satellite in which NASA is a partner.

While 1998 was an outstanding year for Earth Science results, missions launched in 1999 and beyond promise to increase our fundamental understanding of the Earth system. We have 30 Earth Science launches scheduled over the next five years. The President's budget request for Earth Science for FY 2000 is $1.459 billion.

The Earth Observing System (EOS), the largest element of NASA's Earth Science Enterprise (*$663.2 Million for FY 2000*), is a program of multiple spacecraft designed to provide measurements of the key, multi-disciplinary parameters needed to understand global climate change. The first EOS spacecraft -- EOS AM-1 and Landsat-7 -- represent 2 of the 8 missions the Earth Science Enterprise will launch this year. These missions, plus the EOS PM-1 and Chemistry-1 missions, will help achieve the fundamental EOS measurements, which will begin our understanding of the Earth system. PM-1 and Chemistry-1 remain on track for launch in 2000 and 2002, respectively. The EOS program also includes several small spacecraft such as the U.S.-French TOPEX/ Poseidon follow-on mission known as Jason-1, QuikScat, Ice, Cloud and Land Elevation Satellite (ICESAT), Solstice, and the Active Cavity Radiometer Irradiance Monitor (ACRIM) satellite.

The Earth Probes program *($138.2 Million for FY 2000)* addresses specific, highly focused Earth science questions that are new or complementary with other parts of NASA 's Earth Science enterprise. It also has the flexibility to take advantage of new opportunities in international cooperation or technical innovation. Currently approved Earth Probes include the Total Ozone Mapping Spectrometer-EP and the Earth System Science Pathfinder missions (the Vegetation Canopy Lidar and the Gravity Recovery and Climate Experiment). A new US/French ESSP mission called PICASSO-CENA was selected in December 1998 to study the Earth's atmosphere in tandem with the EOS-PM-1 satellite.

A parallel series of New Millennium program missions is being developed to validate advanced technology for future Earth Science spacecraft. The Earth Orbiter-1 mission will demonstrate an advanced land imaging system with a hyperspectral and multispectral capability starting in 1999. The Space-Readiness Coherent Lidar Experiment will fly in the cargo bay of a Space Shuttle in 2001 to test whether a space-based sensor can accurately measure atmospheric winds from the surface to a height of ten miles. Atmospheric winds determine the transport of energy and chemical constituents across the Earth—hence an important parameter for weather prediction. Recognizing the high value of ocean winds data, we have rapidly developed a replacement mission for the failed NSCAT mission called QuikScat, which was ready for launch in November 1998—only 18 months after the loss of NSCAT. Safety concerns with the QuikScat's launch vehicle will push the launch into the spring of 1999. We are also purchasing ocean wind vector data during this interim period between NSCAT and QuikScat.

The EOS Data Information System (EOSDIS *$231.5 Million* for FY 00) has been serving thousands of users by providing available data and information from NASA-sponsored programs since September 1995. EOSDIS will operate the EOS spacecraft, and acquire and distribute the basic data gathered by them. An essential element of EOSDIS, the Flight Operations Segment (FOS) was to provide command and control of EOS spacecraft including the upcoming launch of EOS-AM-1. FOS experienced serious schedule and performance problems throughout 1998, which resulted in replacement of an essential element of FOS with a commercial, off-the-shelf system developed by Raytheon. This new system has enabled EOSDIS to progress toward the goal of meeting all ESE mission needs from now through 2002. Command and control of the EOS-AM-1 mission is currently on schedule for meeting the July 1999 launch date. In addition, EOSDIS is also on track to support operations of the PM-1 (12/00), ICESat (7/01) and Chemistry (11/02) spacecraft.

The Triana mission is an Earth observation spacecraft to be located at the Earth-Sun LaGrange-1 point providing a near-term real time, continuous high definition color view of the full Sun-lit disc of the Earth. This mission will carry three major scientific experiments to make the first direct measurements of the solar radiant power reflected by the Earth, to make global aerosol and ozone measurements, and to observe solar wind. A selection was made in October 1998 for the Scripps Institution of Oceanography to conduct the Triana mission with the Goddard Space Flight Center. Launch is scheduled for December 2000.

Along with basic Earth Science research, we also conduct Applications Research to help universities and State & local governments apply remote sensing data and science to practical problems. We have established five Regional Earth Science Applications Centers (RESACs) to target efforts on specific regional issues. The Commercial Remote Sensing Program (CRSP) at the Stennis Space Center works with industry to extend the utility of ESE's science data within the broader U.S. economy. Through partnerships with CRSP, companies gain assistance in product development and in validation of new remote sensing instruments.

In 1992, CRSP, along with KPMG Peat Marwick, performed a study that valued the remote sensing and geospatial market at $850 million annually, using airborne platforms. In 1998, due to NASA's strides in Earth Observations satellite R&D and corporate commitments, the market was valued at $2 billion. With the anticipated operations of commercial, space-based, high-resolution systems, low-cost positioning data from GPS, enhanced internet access to data and value-added information, underpinned by low-cost, high-performance work stations, industry is projecting a conservative estimate of $4 billion in private investment by 2005.

CRSP's data buy program has been active and robust. In September 1998, NASA awarded five contracts for Phase II of the $50 million Scientific Data Purchase. NASA is developing plans for the next data buy as the commercial remote sensing market matures. Also last year, NASA's CRSP entered into a five-year Joint Sponsored Research Agreement with Mississippi for the purpose of developing commercial remote sensing through collaborative research and public-private partnerships. This year, CRSP will establish at least 75 commercial partnerships in “value-added” remote sensing product development, an increase from 37 in FY 1997. In addition, CRSP will establish at least 20 agreements with industry in support of other federal agency needs. In FY 2000, the CRSP will focus Earth Observing Commercial Applications Program (EOCAP) joint commercial applications research to develop 20 new-market commercial products.

The Earth Science Enterprise balances funding across observations, research and data analysis, applications and commercial remote sensing, information systems, and advanced satellite technologies to ensure the Nation has the tools to answer scientific questions about the Earth, and to put these answers to work for the benefit of society. Earth science is science in the national interest, and NASA is committed to its success.

Aero-Space Technology Enterprise

The Aero-Space Technology Enterprise is working in an exciting and challenging time as we revolutionize the science and technology that powers U.S. civil aeronautics and space transportation. Last year we presented to you an Enterprise program focused on three "Pillars" for success—Global Civil Aviation, Revolutionary Technology Leaps, and Access to Space—and a set of ten goals to address current and future National needs. By developing high technical risk technologies, we contribute to aviation safety, increase air system capacity, enhance environmental compatibility, and open new opportunities in space. Within the past year this Enterprise has had to make some hard choices. Budget pressures, along with shifting industry and market conditions, made it impossible to pursue with excellence all our ambitions. Rather than spread the pain and do a little less of everything, we established a set of priorities among the goals, and are pursuing our top priorities as coordinated with our customers and stakeholders. Our priority goals are aviation safety, aviation systems capacity, next-generation design tools, ultra-efficient engine technology, general aviation, experimental aircraft and access to space. We have dramatically reduced our support to the high-speed civil transport and affordability goals, canceling the High Speed Research and Advanced Subsonic Technology Programs.

We have worked hard over the last year to take advantage of synergies between aeronautics and space transportation activities and are increasing funding in the latter. We have made significant progress in defining the contribution of our existing projects and programs to the goals. We believe these goals will help us better manage our research activities while fostering a better understanding of these activities for the American people. The President's proposed budget for FY 2000 of $1.0065 billion is focused on maximizing a return to our highest priority goals.

Aeronautics

We are proud of our past accomplishments in two focused programs, High Speed Research (HSR) and Advanced Subsonic Technology (AST). Although dramatic advances were made against the original HSR program goals, our industry partners indicated that product development would be significantly delayed, which led to the decision to terminate this program at the end of FY 1999. The need to refocus our technology efforts from industrial competitiveness issues to a broader, more public policy-oriented emphasis resulted in the decision to terminate the AST program at the end of FY 1999.

The aeronautics budget request, $620.1 million, enables us to pursue a new focused program, Aviation Safety, as our top aeronautics priority. As global GDP expands over the next decade by an annual rate of 3 to 4-percent, demand for air travel will dramatically increase – it is expected to triple within 20 years. Great strides have been made over the last 40 years to make flying the safest of all major modes of transportation. However, even today's low accident rate is not good enough and if air traffic triples as predicted, this rate will be totally unacceptable. The national goal is to reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of 10 within 20 years. In addition to accident rate reduction, we will work to decrease injuries and fatalities when accidents do occur. We are also working on aviation system technologies that could support pilots and air traffic controllers. Safety is also a top priority of the FAA. We are working closely with FAA, manufacturers and airlines to prioritize on technology efforts and to ensure their rapid implementation in order to meet our aggressive safety goal. FAA is responsible for the operation and near-term research and development of the National Air Traffic System, while NASA conducts the longer-term, higher-risk research and development. Last October, we signed an MOA with the FAA to solidify our cooperation in this area.

Our FY 2000 budget also support the Aviation Systems Capacity (ASC) Program, which builds on research we have conducted over the past few years in the Advanced Subsonic Technology program. Our goal in capacity is “while maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.” This is absolutely required if the aviation system is to keep up with demand and allow the predicted growth in air travel to occur. The ASC program is looking at modernization and improvements in the Air Traffic Management System and the introduction of new vehicle classes which can potentially reduce congestion. Efficient and flexible routing, scheduling and sequencing of aircraft in all weather conditions are critical to meeting capacity demands. As in safety, we are working closely with FAA on this program.

I am very excited about our work in experimental aircraft. On August 6, 1998, the solar-powered Pathfinder Remotely Piloted Aircraft broke its own world altitude record for a solar-powered aircraft by almost 10,000 feet, and established a world record for propeller driven aircraft of 80,201 feet. This flight was another step in meeting the challenge of flying a solar powered aircraft at 100,000 feet. In another first, an international cooperative project with the Russian Central Institute of Aviation Motors achieved the first extended supersonic combustion in flight using a scramjet flown to Mach 6. The X-43 (HYPER-X) research vehicle, which is an air-breathing, dual-mode scramjet-powered plane capable of speeds up to Mach 10, will be delivered this year and will have its first powered flight (to Mach 7) in FY 2000. Experimental aircraft such as these are invaluable tools for exploring new concepts and for complementing and strengthening laboratory research. In the very demanding environment of flight, X-planes are used to test innovative, high-risk concepts, accelerating their development into design and technology applications.

We are pioneering a new safe and efficient general aviation air transportation system that will allow us to travel up to four times faster than we can by car from doorstep to destination, even if that doorstep or destination is a small community many miles from a large hub airport. To make this possible, NASA has been working and will continue to work on advances in propulsion and avionics that will make general aviation affordable and safe.

Our FY 2000 budget includes the Ultra Efficient Engine Technology Program and REVCON, or revolutionary concepts. The Ultra Efficient Engine Technology Program will enable the next breakthroughs in propulsion systems that will spawn a new generation of high-performance, operationally efficient, economically viable and environmentally compatible U.S. aircraft. We will develop and demonstrate breakthrough technologies in propulsion component and high-temperature engine materials which can create future commercial and military propulsion systems which are simpler, achieve higher performance, and do less damage to the environment. REVCON is a process that will develop concepts that are a revolutionary departure from traditional approaches to aeronautical design. We will fully utilize the next-generation design tools we are developing to produce substantial benefits in concept development. REVCON will change fundamentally the way systems are designed and accelerate the transition of high-risk/high-payoff technology from the laboratory to flight.

Advanced Space Transportation Technology

The Advanced Space Transportation Technology program supports our "Access to Space" pillar. Our goal is to completely revitalize access to space by reducing launch costs dramatically over the next decade, increasing the safety and reliability of current and next generation launch vehicles, and establishing new plateaus of performance for in-space propulsion while reducing cost and weight. We are committed to developing technology that will reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1,000 per pound, within 10 years. The budget request, $254 million, fully supports this goal.

NASA's Reusable Launch Vehicle (RLV) Program includes both ground-based technology development and flight demonstrators (X-33, X-34, Future-X Pathfinder vehicles) to validate key component technologies, prove that the technologies can be integrated into a functional vehicle, and demonstrate the required operability to make low-cost access to space a reality. Once demonstrated, we expect that these technologies will be used by private industry to build next-generation launch vehicles that will meet government and commercial needs at dramatically reduced costs.

Early last year the X-33's first major flight component, the liquid oxygen tank, was placed in the vehicle's assembly structure. The X-33 launch site at Edwards Air Force Base is nearly complete. The technologies we are developing are risky, and development problems are not unexpected. In fact, the landing gear is the only piece of existing hardware on the X-33. All other components require advanced development. Recently, the X-33 program has experienced some manufacturing and technical problems that have led to a slip in the first flight to July 2000. We are working with the industry team to resolve these problems and expect no additional cost to the government. The X-34 also has experienced some manufacturing difficulties that will delay the first unpowered flight four months to September 1999; the first powered flight is currently scheduled for February 2000. We are confident that these problems will be overcome and these programs will provide valuable technology for application to future space launch vehicles.

In FY 1999, we initiated the Future-X program which includes “Pathfinder” flight experiments for demonstrations of technologies which can further reduce the cost and increase the reliability of reusable space launch and orbital transportation systems. We are particularly pleased with the selection of the Advanced Technology Vehicle (ATV), the first contract award under Future-X. The ATV includes cost-sharing by industry and possibly the Air Force. We are working closely with the Air Force on this program to ensure it will meet defense as well as civil space needs. We are strengthening the links between the Advanced Space Transportation Program, which is a technology development program, and Future-X flight validation; we want to make more transparent the decision-making mechanism for determining if an ASTP technology truly requires flight validation in Future-X. ASTP will continue to push the state-of-the-art technologies that will be flown under the Future-X program if required for validation prior to implementation in commercial, DOD or civil transportation systems.

We have restructured the Small-Payload Focused Project (Bantam). Its goal is to develop and demonstrate unique technologies that will enable the development of a reusable launch system that will launch 200 to 300-pound payloads for $1-to-$1.5 million per flight by 2004/2005. The ground technology program, commercial market, and provider developments will support decisions on whether to pursue a Future-X flight demonstration of the most promising vehicle concept. Concepts currently under study include multi-stage rockets, air-breathing combined-cycle vehicles, magnetic levitation launch assist, and beamed-energy laser-powered vehicles—to name a few. In FY 2000, the results of these technology demonstrations and system level analyses of multiple concepts will support concept down-selection. As we proceed with this program, we will periodically solicit proposals from industry to supply such a launch vehicle for this payload class and as with all NASA technology programs, industry will have access to the technology as we develop it.

Commercial Technology

Since its inception in 1958, NASA has been charged with ensuring that NASA-developed technology is transferred to the U.S. industrial community to improve its competitive position in world markets. The FY 2000 budget request of $132.5 million continues this important aspect of our mission. Our commercialization effort encompasses all technologies created at NASA centers by civil servants as well as innovations from NASA contractors. The technology commercialization program conducts a continuous inventory of newly developed NASA technologies, maintains an internet-based database of this inventory, assesses the commercial value of each technology, establishes R&D partnerships with industry for dual use of the technology, disseminates knowledge of these NASA technology opportunities to the private sector, and supports an efficient system for licensing NASA technologies to private companies. The amount requested for NASA commercialization efforts includes $97.5 million to carry out the provisions of the Small Business Innovation Research (SBIR) Act, which requires a set-aside of 2.5% of NASA's total extramural R&D spending for small business research grants, along with an additional set-aside for the Small Business Technology Transfer (STTR) Program of 0.15% of NASA's total extramural R&D spending. The NASA SBIR program has contributed to the U.S. economy by fostering the establishment and growth of over 1,100 small, high technology businesses.

Conclusion

Mr. Chairman, I am proud of NASA and I am pleased with this budget. It gives us the stability we need to continue the construction of the ISS and to conduct cutting-edge research in science and technology. There is no question that the ISS partnership will continue to face challenges. But if the successes of the last few months are any indication of our ability to jointly overcome difficulties and succeed, I look forward to the coming year with great enthusiasm. While we are building this magnificent international laboratory in space, we already are studying how we can make this facility a seed for commercial space activity for the early part of the next century, and for opening the space frontier for human activity beyond low-Earth orbit. Like the railroads, the Government will build it, and it will create entirely new opportunities for private enterprise. To get there, we will continue to fly the Shuttle safely while developing new technologies that could make space launch more affordable and reliable. We look forward to a robust competition for NASA's launch business among several providers in the next decade. We will not just be going to low-Earth orbit, as NASA will continue to push the frontiers of knowledge about our planet, our Solar System, and our Universe. Micro-rovers will look for signs of ancient life on Mars, and perhaps existing life on the moons of Jupiter and Saturn, while we continue to search for planets in nearby solar systems that could also harbor life today. This budget is the beginning of a new era in vehicle and mission design, as we create an Integrated Synthesis Environment that will dramatically lower costs and reduce development times, allowing us to do even more exciting science and technology.

NASA remains committed to providing the American taxpayer with the best possible space and aeronautics program in the world. Our accomplishments demonstrate we are capable of that. We are determined to continue that tradition. I truly believe the best is yet to come.

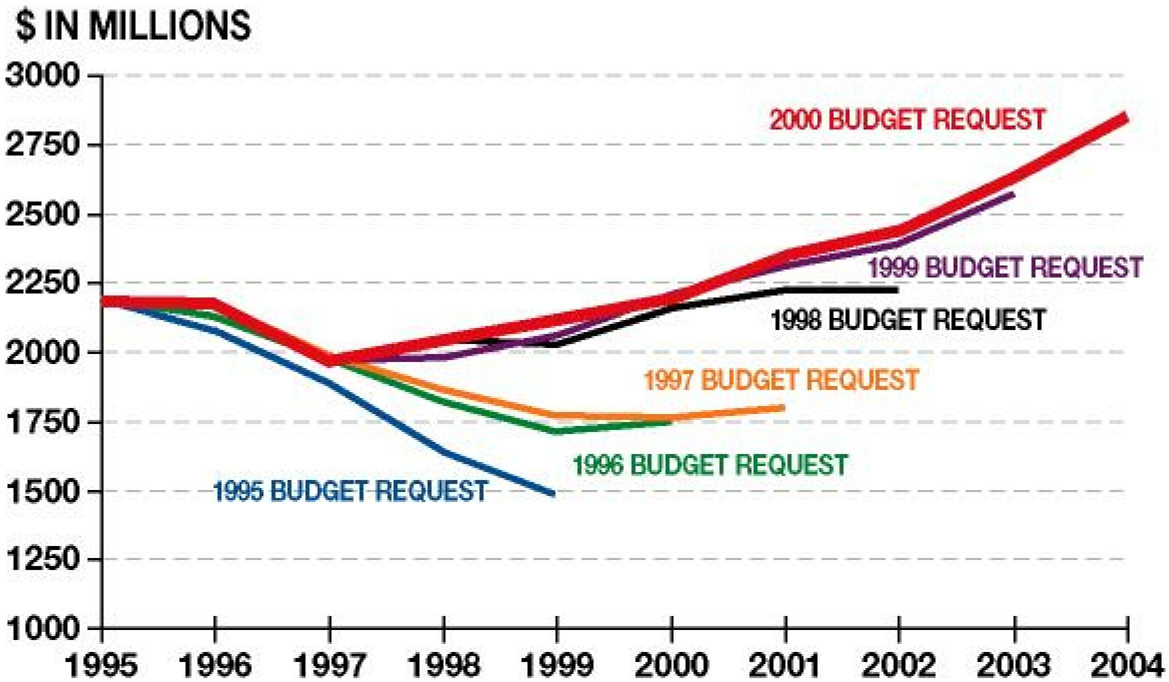
Accompanying Charts

- FY 2000 Budget by Function (38 K)
- Space Science Budget Requests, FY 1995-2004 (53 K)
- NASA's Faster, Better, Cheaper Approach (42 K)
- Cost Comparison - Galileo and New Planetary Missions (48 K)
- Shuttle Delivering More for the Money (50 K)
- Greatly Reduced Shuttle Cost (51 K)
- Significant Shuttle Safety Improvements (46 K)
- FY 2000 Budget vs. History, yearly funding (38

K)

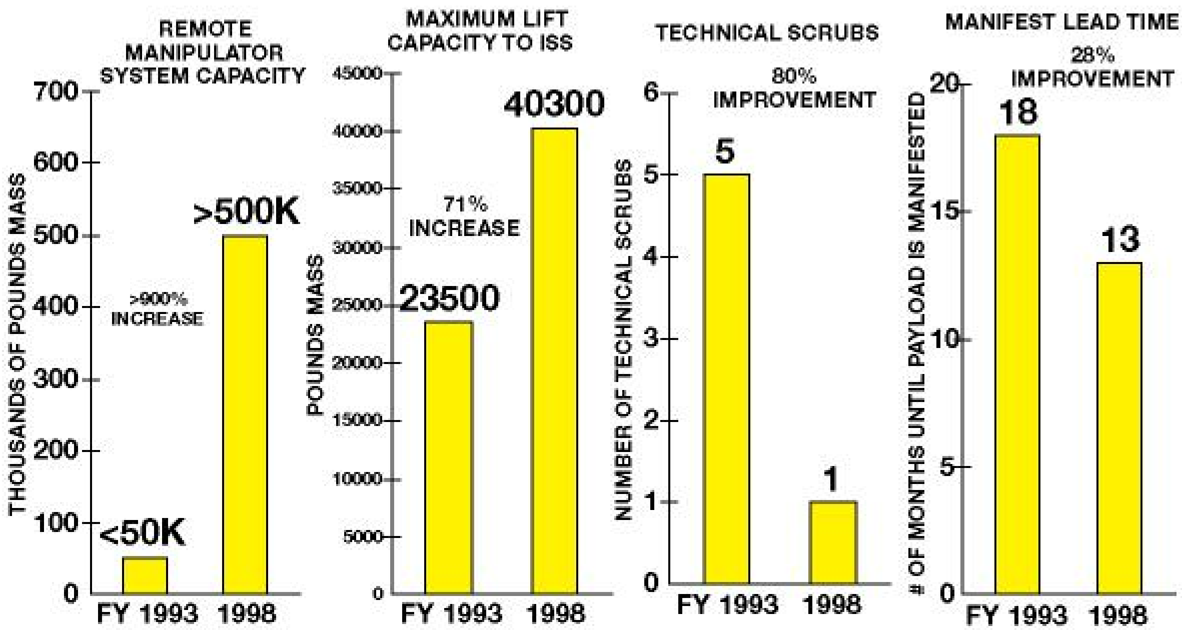
- FY 2000 Budget vs. History, outyear projections (39 K)
- Space Science and Space Station Funding in the FY 2000 Budget
- Human Space Flight and Science Funding in the FY 2000 Budget

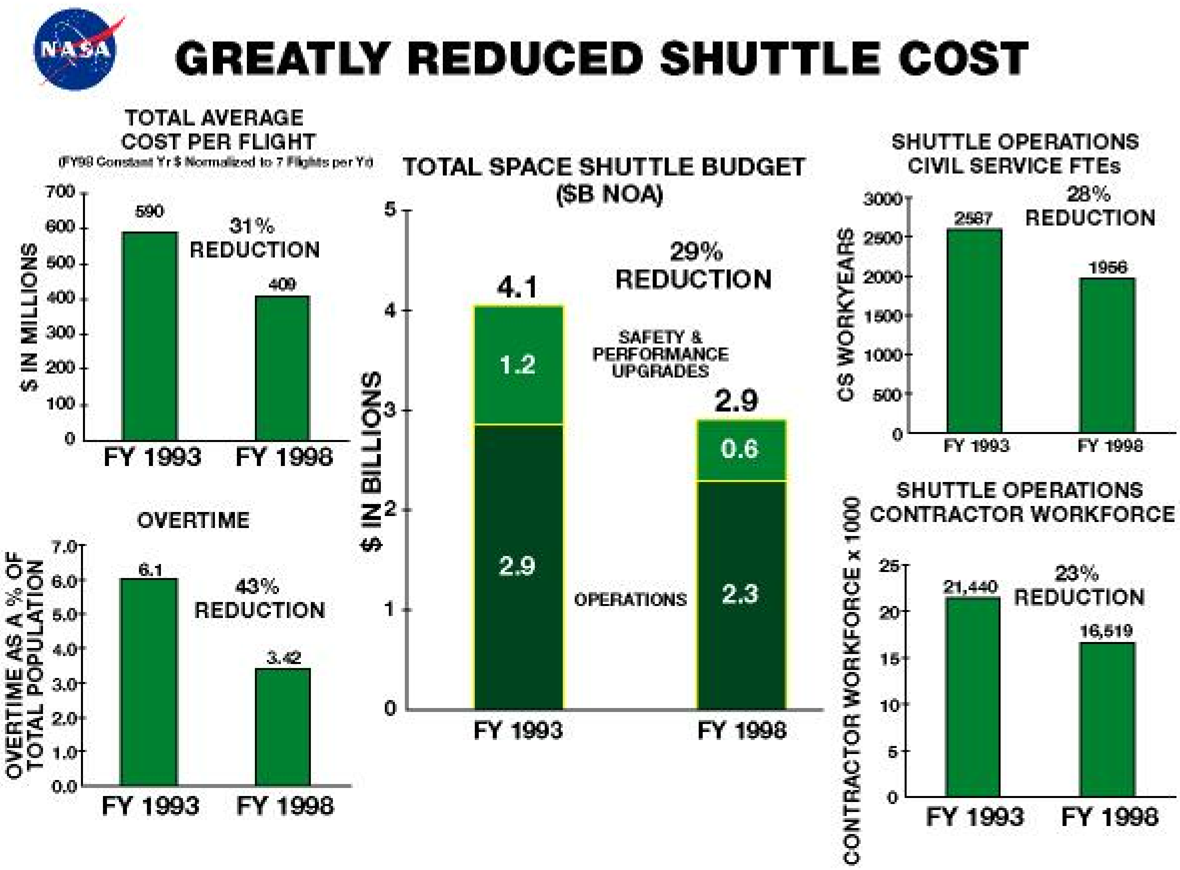
FY 2000 BUDGET
SPACE SCIENCE BUDGET REQUESTS *



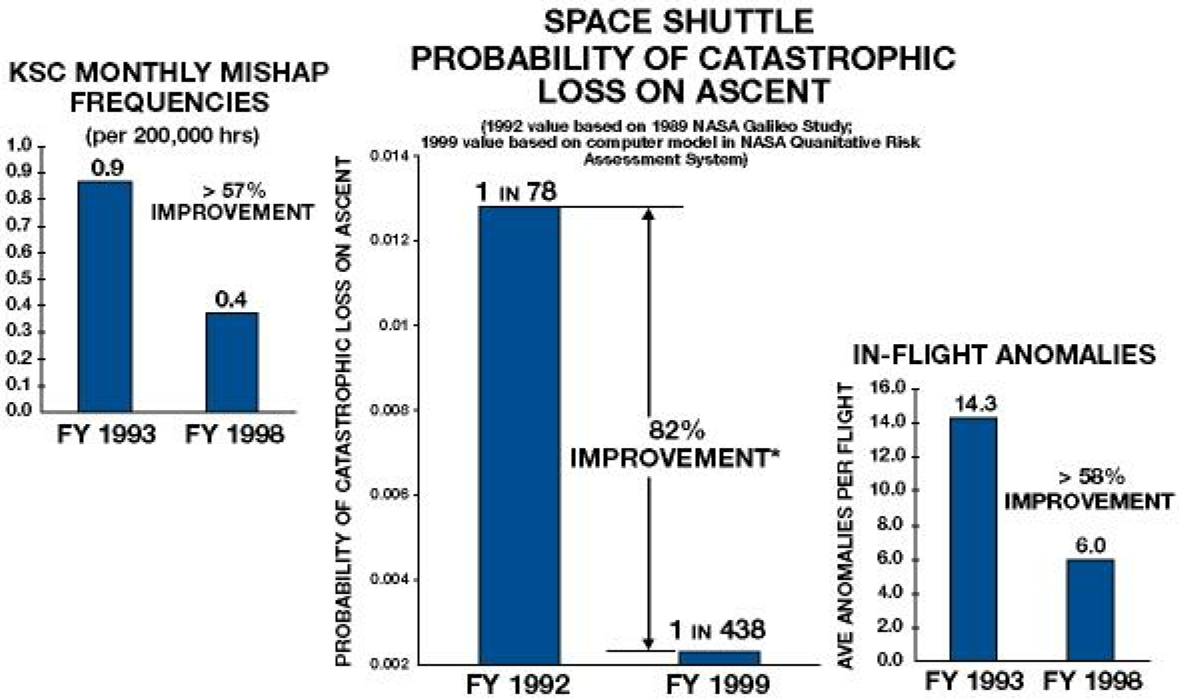
* FY 95-97 REQUESTS ADJUSTED TO REFLECT TRANSFERS OF ELV, HPCC, AND CROSSCUTTING TECHNOLOGY PROGRAMS TO OSS BUDGET

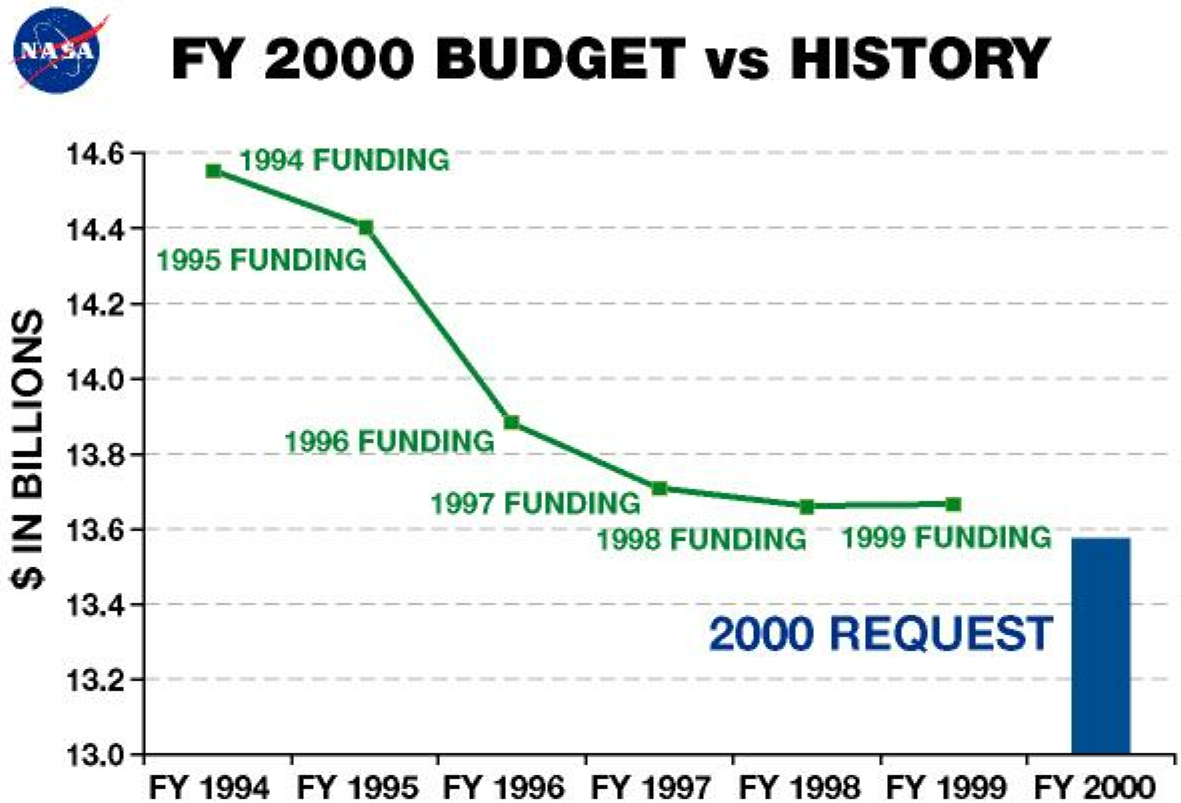
SHUTTLE DELIVERING MORE FOR THE MONEY

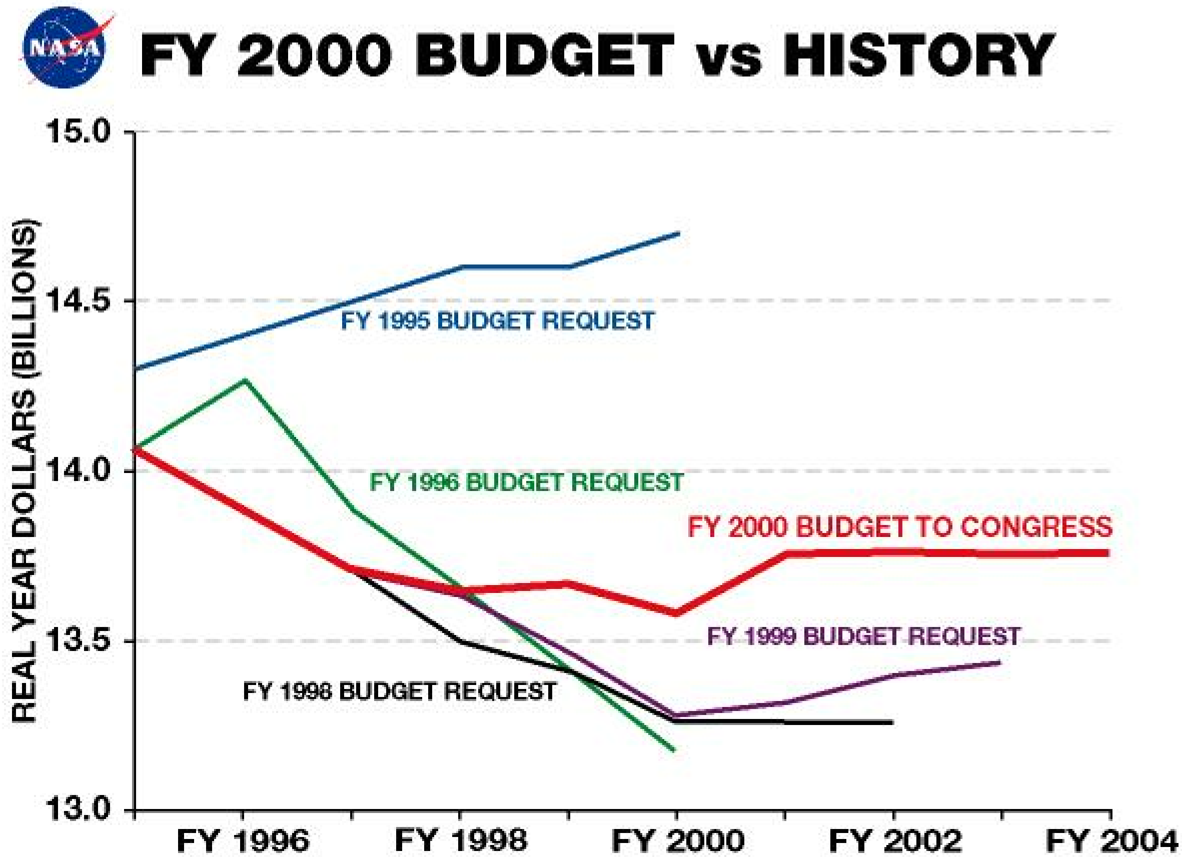


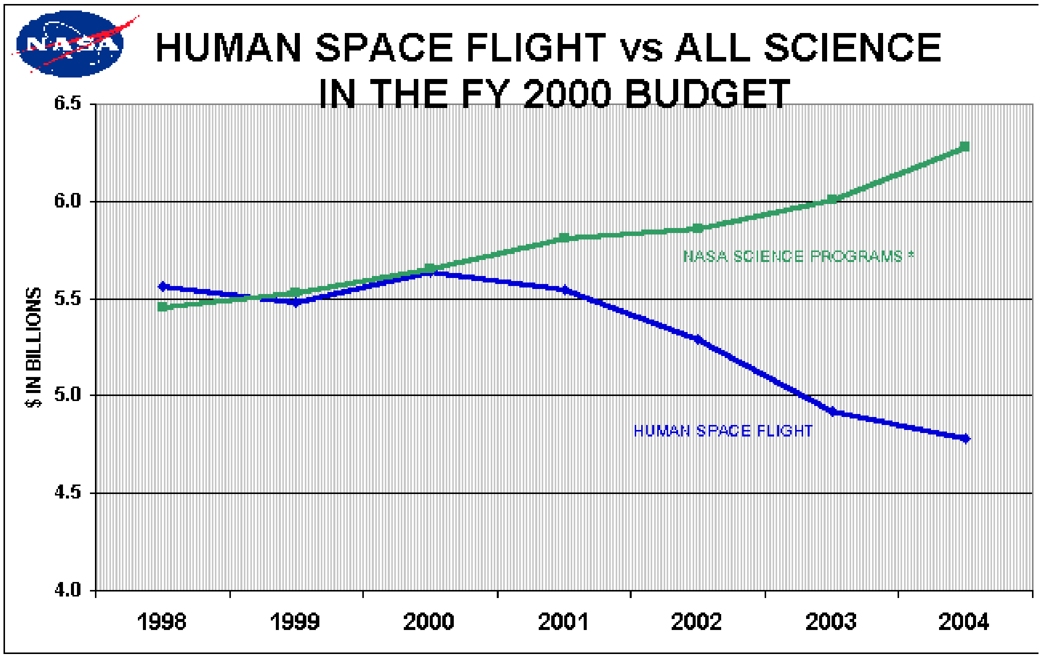

GREATLY REDUCED SHUTTLE COST
TOTAL AVERAGE COST PER FLIGHT
(FY98 Constant Yr $ Normalized to 7 Flights per Yr)
$ IN MILLIONS
590
409
31% REDUCTION
FY 1993
FY 1998
TOTAL SPACE SHUTTLE BUDGET ($B NOA)
$ IN BILLIONS
4.1
2.9
29% REDUCTION
SAFETY & PERFORMANCE UPGRADES
OPERATIONS
1.2
2.9
0.6
2.3
SHUTTLE OPERATIONS CIVIL SERVICE FTEs
CS WORKYEARS
2587
1956
28% REDUCTION
OVERTIME
OVERTIME AS A % OF TOTAL POPULATION
6.1
3.42
43% REDUCTION
SHUTTLE OPERATIONS CONTRACTOR WORKFORCE
CONTRACTOR WORKFORCE x 1000
21,440
16,519
23% REDUCTION

SIGNIFICANT SHUTTLE SAFETY IMPROVEMENTS

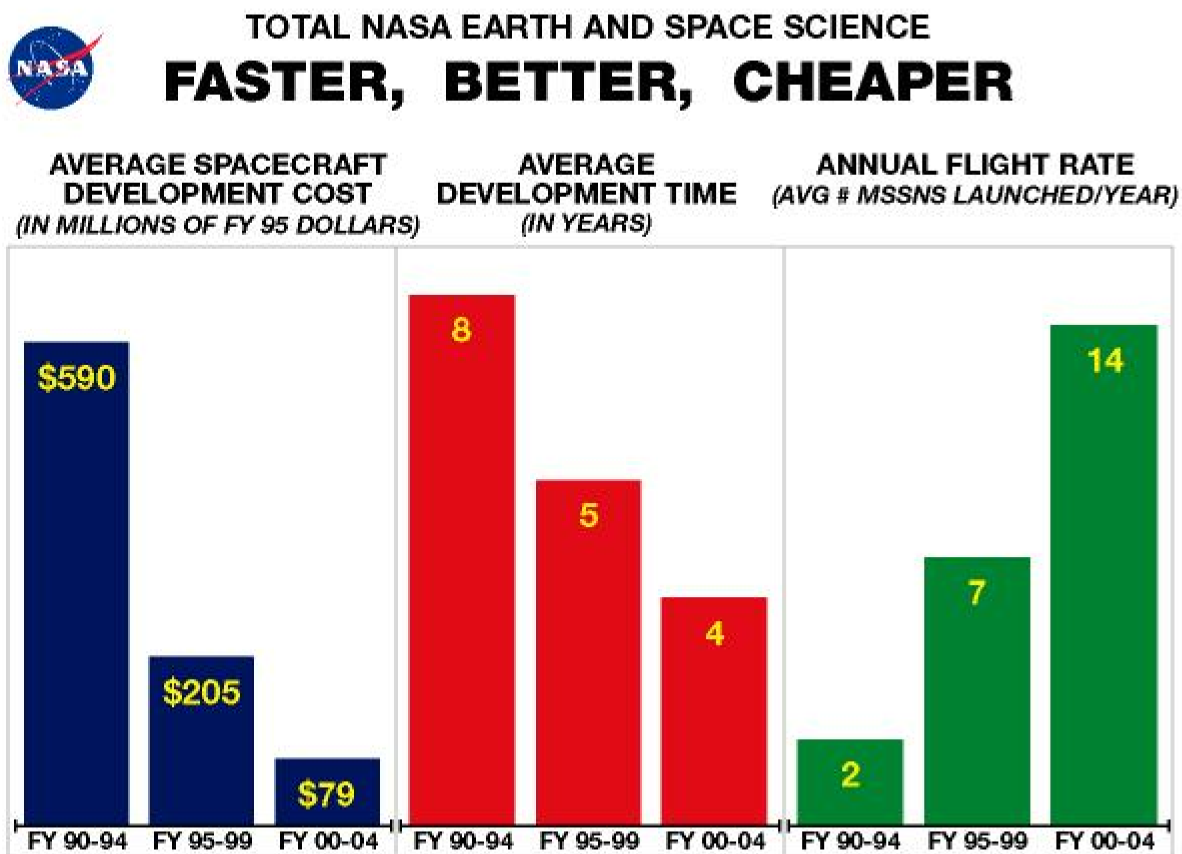



FY 2000 BUDGET vs HISTORY
$ IN BILLIONS
14.6
14.4
14.2
14.0
13.8
13.6
13.4
13.2
13.0
1994 FUNDING
1995 FUNDING
1996 FUNDING
1997 FUNDING
1998 FUNDING
1999 FUNDING
2000 REQUEST
FY 1994
FY 1995
FY 1996
FY 1997
FY 1998
FY 1999
FY 2000

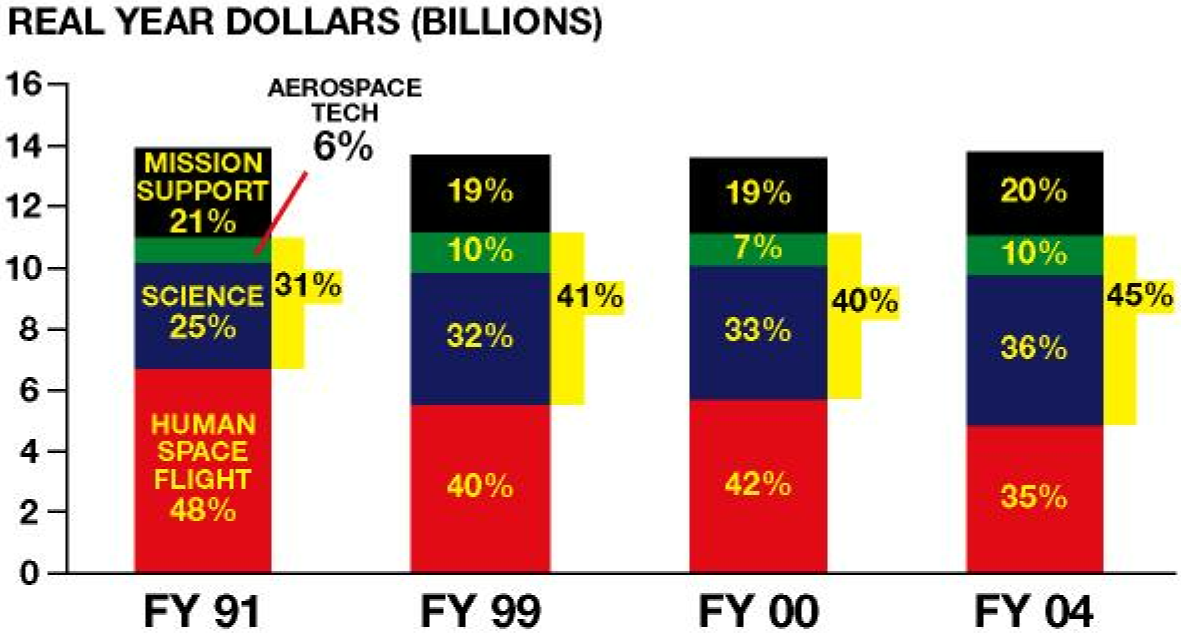

FY 2000 BUDGET vs HISTORY
REAL YEAR DOLLARS (BILLIONS)
15.0
14.5
14.0
13.5
13.0
FY 1995 BUDGET REQUEST
FY 1996 BUDGET REQUEST
FY 2000 BUDGET TO CONGRESS
FY 1999 BUDGET REQUEST
FY 1998 BUDGET REQUEST
FY 1996
FY 1998
FY 2000
FY 2002
FY 2004

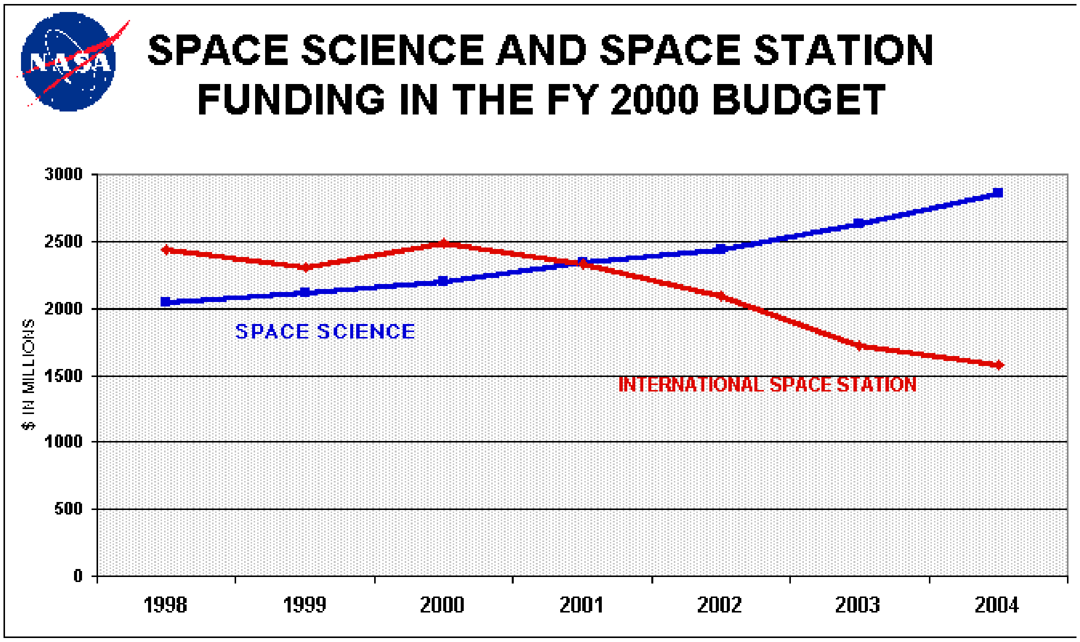


HUMAN SPACE FLIGHT vs ALL SCIENCE
IN THE FY 2000 BUDGET
$ IN BILLIONS
6.5
6.0
5.5
5.0
4.5
4.0
1998
1999
2000
2001
2002
2003
2004
NASA SCIENCE PROGRAMS *
HUMAN SPACE FLIGHT


TOTAL NASA EARTH AND SPACE SCIENCE
FASTER, BETTER, CHEAPER
AVERAGE SPACECRAFT DEVELOPMENT COST
(IN MILLIONS OF FY 95 DOLLARS)
AVERAGE DEVELOPMENT TIME
(IN YEARS)
ANNUAL FLIGHT RATE
(AVG # MSSNS LAUNCHED/YEAR)
$590
$205
$79
8
5
4
2
7
14
FY 90-94
FY 95-99
FY 00-04
FY 90-94
FY 95-99
FY 00-04
FY 90-94
FY 95-99
FY 00-04

FY 2000 BUDGET




SPACE SCIENCE AND SPACE STATION
FUNDING IN THE FY 2000 BUDGET
$ IN MILLIONS
3000
2500
2000
1500
1000
500
0
1998
1999
2000
2001
2002
2003
2004
SPACE SCIENCE
INTERNATIONAL SPACE STATION